CLAIMS

1. An optical pick-up to perform recording or reproducing for an optical recording medium, comprising:

a light source configured to emit a light beam,

an objective lens configured to focus the light beam onto the optical recording medium, and

an aberration generation device provided between the light source and the objective lens, configured to generate coma aberration for the beam focused by the objective lens, based on a detected value from a device configured to detect a degree of tilt of the optical recording medium,

wherein the tilt is compensated for by the coma aberration generated by the aberration generation device.

2. The optical pick-up as claimed in claim 1, wherein

the aberration generation device is composed of two lenses with refractive powers different from each other and a driving device,

at least one of the lenses is moved along a direction of an optical axis to generate spherical aberration, and

the other lens is moved along a direction orthogonal to the optical axis to generate coma aberration.

3. The optical pick-up as claimed in claim 1, wherein the aberration generation device has an electrode pattern configured to generate coma aberration and an electrode pattern configured to generate spherical aberration and is a liquid crystal element that sandwiches a liquid crystal layer.

4. The optical pick-up as claimed in claim 1, wherein the aberration generation device generates coma aberration in a radial direction of the optical recording medium.

5. An optical pick-up to perform recording or reproducing of information for a first optical recording medium with a wavelength $\lambda 1$, a thickness t1 of a substrate thereof, and a numerical aperture NA1 for use thereof and a second optical recording medium with a wavelength $\lambda 1$, a thickness t2 (> t1) of a substrate thereof, and a numerical aperture NA2 (< NA1) for use thereof, comprising:

an aberration generation device configured to generate coma aberration or spherical aberration for a beam focused by an objective lens,

a device configured to perform a first control operation comprising

a first step of making a quantity of the coma aberration generated by the aberration generation device be a stored and predetermined value when a medium determination device configured to determine which of the first and second optical recording media is set determines that the first optical recording medium is set,

a second step of changing a quantity of the spherical aberration generated by the aberration generation device to store a driving condition of the aberration generation device on which condition an amplitude of a recording information signal or a track error signal is maximum, and

a third step of performing an operation of recording or reproducing while a quantity of the spherical aberration is added based on the driving condition, and

a device configured to perform a second control operation comprising

a fourth step of making a quantity of the spherical aberration generated by the aberration generation device be a stored and predetermined value when the medium determination device determines that the second optical recording medium is set,

a fifth step of changing a quantity of the coma aberration generated by the aberration generation device, to store a driving condition of the aberration generation

device on which condition an amplitude of a recording information signal or a track error signal is maximum, and

a sixth step of performing an operation of recording or reproducing while the quantity of the coma aberration is added based on the driving condition,

wherein the aberration generation device is controlled by the device for the first and second control operations.

6. The optical pick-up as claimed in claim 5, wherein

the aberration generation device is composed of two lenses with refractive powers different from each other and a driving device,

at least one of the lenses is moved along a direction of an optical axis to generate spherical aberration, and

the other lens is moved along a direction orthogonal to the optical axis to generate coma aberration.

7. The optical pick-up as claimed in claim 5, wherein the aberration generation device has an electrode pattern configured to generate coma aberration and an electrode pattern configured to generate spherical aberration and is a liquid crystal element that sandwiches a liquid

crystal layer.

8. The optical pick-up as claimed in claim 5, wherein the aberration generation device generates coma aberration in a radial direction of the optical recording medium.

9. The optical pick-up as claimed in claim 5, wherein the aberration generation device generates under-spherical aberration at a time of recording or reproducing for the first optical recording medium and generates over-spherical aberration at a time of recording or reproducing for the second optical recording medium, at a center point of a beam focused by the objective lens to which beam no aberration is added.

10. The optical pick-up as claimed in claim 5, wherein a value on a condition on which aberration is best or an information signal is best in a process of assembling the optical pick-up is stored as the predetermined value, which value is used as a center point of the spherical aberration or the coma aberration generated by the aberration generation device.

11. The optical pick-up as claimed in claim 5,

wherein the objective lens is a lens providing a best aberration for the first optical recording medium and is provided with an aberration compensation element comprising a diffraction element or a phase shifter element between the objective lens and the aberration generation device.

12. The optical pick-up as claimed in claim 11, wherein the aberration compensation element is provided with a diffraction element whereby recording or reproducing is made using light beams with selectively different diffraction orders dependent on an optical recording medium.

13. The optical pick-up as claimed in claim 11, wherein the diffraction element is molded with the objective lens as one unit and a diffraction grating is formed on a surface of the objective lens at a side of a light source.

14. An optical pick-up to perform recording or reproducing of information for an optical recording medium in which p layers ($p \geq 2$) each with an information-recording surface are formed in a direction of a thickness thereof of which layers ($p - q$) layer(s) at a front side near an objective lens is/are an information recording layer(s) with high recording density and q layer(s) at a back side away from the objective lens is/are an information recording layer(s)

with low recording density, comprising:

an aberration generation device configured to generate coma aberration or spherical aberration for a beam focused by the objective lens,

a device configured to perform a first control operation comprising

a first step of making a quantity of the coma aberration generated by the aberration generation device be a stored and predetermined value when recording or reproducing of information is performed for the (p - q) layer(s) of the optical recording medium at the front side near the objective lens,

a second step of changing a quantity of the spherical aberration generated by the aberration generation device to store a driving condition of the aberration generation device on which condition an amplitude of a recording information signal or a track error signal is maximum, and

a third step of performing an operation of recording or reproducing while a spherical aberration is added based on the driving condition, and

a device configured to perform a second control operation comprising

a fourth step of making a quantity of the spherical aberration generated by the aberration generation

device be a stored and predetermined value when recording or reproducing of information is performed for the q layer(s) of the optical recording medium at the back side away from the objective lens,

a fifth step of changing a quantity of the coma aberration generated by the aberration generation device to store a driving condition of the aberration generation device on which condition an amplitude of a recording information signal or a track error signal is maximum, and

a sixth step of performing an operation of recording or reproducing while coma aberration is added based on the driving condition,

wherein control of the aberration generation device is performed by the device configured to perform the first and second control operations.

15. The optical pick-up as claimed in claim 14, wherein

the aberration generation device is composed of two lenses with refractive powers different from each other and a driving device,

at least one of the lenses is moved along a direction of an optical axis to generate spherical aberration, and

the other lens is moved along a direction

orthogonal to the optical axis to generate coma aberration.

16. The optical pick-up as claimed in claim 14, wherein the aberration generation device has an electrode pattern configured to generate coma aberration and an electrode pattern configured to generate spherical aberration and is a liquid crystal element that sandwiches a liquid crystal layer.

17. The optical pick-up as claimed in claim 14, wherein the aberration generation device generates coma aberration in a radial direction of the optical recording medium.

18. The optical pick-up as claimed in claim 14, wherein the aberration generation device generates under-spherical aberration at a time of recording or reproducing for the (p - q) layer(s) of the optical recording medium at the front side near the objective lens and generates over-spherical aberration at a time of recording or reproducing for the q layer(s) of the optical recording medium at the back side away from the objective lens, at a center point of a beam focused by the objective lens to which beam no aberration is added.

19. The optical pick-up as claimed in claim 14, wherein a value on a condition on which aberration is best or an information signal is best in a process of assembling the optical pick-up is stored as the predetermined value, which value is used as a center point of the spherical aberration or the coma aberration generated by the aberration generation device.

20. The optical pick-up as claimed in claim 14, wherein the optical recording medium has, at least, information-recording surfaces at any two or more thickness positions of 0.1 mm, 0.6 mm, and 1.2 mm from a side of the objective lens.

21. A method of generating aberration for compensation for an optical pick-up to perform recording or reproducing for an optical recording medium, wherein a light beam emitted from a light source is focused on the optical recording medium through an objective lens and coma aberration is generated for a beam focused by the objective lens, based on a detected value from a tilt quantity detecting device for the optical recording medium, by an aberration generation device provided between the light source and the objective lens, so as to perform tilt compensation based on a quantity

of the generated coma aberration.

22. The method of generating aberration for compensation as claimed in claim 21, wherein

the aberration generation device is composed of two lenses with refractive powers different from each other and a driving device,

at least one of the lenses is moved along a direction of an optical axis to generate spherical aberration, and

the other lens is moved along a direction orthogonal to the optical axis to generate coma aberration.

23. The method of generating aberration for compensation as claimed in claim 21, wherein the aberration generation device has an electrode pattern configured to generate coma aberration and an electrode pattern configured to generate spherical aberration and is a liquid crystal element that sandwiches a liquid crystal layer.

24. The method of generating aberration for compensation as claimed in claim 21, wherein the aberration generation device generates coma aberration in a radial direction of the optical recording medium.

25. A method of generating aberration for compensation for an optical pick-up to perform recording or reproducing of information for a first optical recording medium with a wavelength $\lambda 1$, a thickness t1 of a substrate thereof, and a numerical aperture NA1 for use thereof and a second optical recording medium with a wavelength $\lambda 1$, a thickness t2 (> t1) of a substrate thereof, and a numerical aperture NA2 (< NA1) for use thereof, which performs, as a control of an aberration generation device configured to generate coma aberration or spherical aberration for a beam focused by an objective lens,

a first control operation comprising

a first step of making a quantity of the coma aberration generated by the aberration generation device be a stored and predetermined value when a medium determination device configured to determine which of the first and second optical recording media is set determines that the first optical recording medium is set,

a second step of changing a quantity of the spherical aberration generated by the aberration generation device to store a driving condition of the aberration generation device on which condition an amplitude of a recording information signal or a track error signal is maximum, and

a third step of performing an operation of

recording or reproducing while a quantity of the spherical aberration is added based on the driving condition, and

a second control operation comprising

a fourth step of making a quantity of the spherical aberration generated by the aberration generation device be a stored and predetermined value when the medium determination device determines that the second optical recording medium is set,

a fifth step of changing a quantity of the coma aberration generated by the aberration generation device, to store a driving condition of the aberration generation device on which condition an amplitude of a recording information signal or a track error signal is maximum, and

a sixth step of performing an operation of recording or reproducing while the quantity of the coma aberration is added based on the driving condition.

26. The method of generating aberration for compensation as claimed in claim 25, wherein

the aberration generation device is composed of two lenses with refractive powers different from each other and a driving device,

at least one of the lenses is moved along a direction of an optical axis to generate spherical aberration, and

the other lens is moved along a direction orthogonal to the optical axis to generate coma aberration.

27. The method of generating aberration for compensation as claimed in claim 25, wherein the aberration generation device has an electrode pattern configured to generate coma aberration and an electrode pattern configured to generate spherical aberration and is a liquid crystal element that sandwiches a liquid crystal layer.

28. The method of generating aberration for compensation as claimed in claim 25, wherein the aberration generation device generates coma aberration in a radial direction of the optical recording medium.

29. The method of generating aberration for compensation as claimed in claim 25, wherein the aberration generation device generates under-spherical aberration at a time of recording or reproducing for the first optical recording medium and generates over-spherical aberration at a time of recording or reproducing for the second optical recording medium, at a center point of a beam focused by the objective lens to which beam no aberration is added.

30. The method of generating aberration for

compensation as claimed in claim 25, wherein a value on a condition on which aberration is best or an information signal is best in a process of assembling the optical pick-up is stored as the predetermined value, which value is used as a center point of the spherical aberration or the coma aberration generated by the aberration generation device.

31. A method of generating aberration for compensation for an optical pick-up to perform recording or reproducing of information for an optical recording medium in which p layers ($p \geq 2$) each with an information-recording surface are formed in a direction of a thickness thereof of which layers $(p - q)$ layer(s) at a front side near an objective lens is/are an information recording layer(s) with high recording density and q layer(s) at a back side away from the objective lens is/are an information recording layer(s) with low recording density, which performs, as a control of an aberration generation device configured to generate coma aberration or spherical aberration for a beam focused by the objective lens,

a first control operation comprising

a first step of making a quantity of the coma aberration generated by the aberration generation device be a stored and predetermined value when recording or reproducing of information is performed for the $(p - q)$ layer(s) of the

optical recording medium at the front side near the objective lens,

a second step of changing a quantity of the spherical aberration generated by the aberration generation device to store a driving condition of the aberration generation device on which condition an amplitude of a recording information signal or a track error signal is maximum, and

a third step of performing an operation of recording or reproducing while a spherical aberration is added based on the driving condition, and

a second control operation comprising

a fourth step of making a quantity of the spherical aberration generated by the aberration generation device be a stored and predetermined value when recording or reproducing of information is performed for the q layer(s) of the optical recording medium at the back side away from the objective lens,

a fifth step of changing a quantity of the coma aberration generated by the aberration generation device to store a driving condition of the aberration generation device on which condition an amplitude of a recording information signal or a track error signal is maximum, and

a sixth step of performing an operation of recording or reproducing while coma aberration is added based

on the driving condition.

32. The method of generating aberration for compensation as claimed in claim 31, wherein

the aberration generation device is composed of two lenses with refractive powers different from each other and a driving device,

at least one of the lenses is moved along a direction of an optical axis to generate spherical aberration, and

the other lens is moved along a direction orthogonal to the optical axis to generate coma aberration.

33. The method of generating aberration for compensation as claimed in claim 31, wherein the aberration generation device has an electrode pattern configured to generate coma aberration and an electrode pattern configured to generate spherical aberration and is a liquid crystal element that sandwiches a liquid crystal layer.

34. The method of generating aberration for compensation as claimed in claim 31, wherein the aberration generation device generates coma aberration in a radial direction of the optical recording medium.

35. The method of generating aberration for compensation as claimed in claim 31, wherein the aberration generation device generates under-spherical aberration at a time of recording or reproducing for the (p - q) layer(s) of the optical recording medium at the front side near the objective lens and generates over-spherical aberration at a time of recording or reproducing for the q layer(s) of the optical recording medium at the back side away from the objective lens, at a center point of a beam focused by the objective lens to which beam no aberration is added.

36. The method of generating aberration for compensation as claimed in claim 31, wherein a value on a condition on which aberration is best or an information signal is best in a process of assembling the optical pick-up is stored as the predetermined value, which value is used as a center point of the spherical aberration or the coma aberration generated by the aberration generation device.

37. An optical information processing apparatus to perform recording or reproducing of information for an optical recording medium, wherein the optical pick-up as claimed in claim 1 is provided.

38. An optical information processing apparatus to

perform recording or reproducing of information for an optical recording medium, wherein the optical pick-up as claimed in claim 5 is provided.

39. An optical information processing apparatus to perform recording or reproducing of information for an optical recording medium, wherein the optical pick-up as claimed in claim 14 is provided.

40. An optical information processing apparatus to perform recording or reproducing of information for an optical recording medium, wherein the method of generating aberration for compensation as claimed in claim 21 is used.

41. An optical information processing apparatus to perform recording or reproducing of information for an optical recording medium, wherein the method of generating aberration for compensation as claimed in claim 25 is used.

42. An optical information processing apparatus to perform recording or reproducing of information for an optical recording medium, wherein the method of generating aberration for compensation as claimed in claim 31 is used.